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PTO/SB/05 (2/98)

**UTILITY
PATENT APPLICATION
TRANSMITTAL**

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.

TI-22451

First Named Inventor or Application Identifier

Ronald B. Azcarate

Title

STRAPLESS LEAD FRAME

Express Mail Label No.

EL360239555US

On Page 1 of the specification, before line 1, insert -This application claims priority under 35 USC § 119(e)(1) of provisional application number **60/099,595** filed **09/09/98**--

APPLICATION ELEMENTS

See MPEP Chapter 600 concerning utility patent application contents

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| 1. <input checked="" type="checkbox"/> *Fee Transmittal Form (e.g., PTO/SB/17) (Submit an original, and a duplicate for fee processing) | 6. <input type="checkbox"/> Microfiche Computer Program (Appendix) |
| 2. <input checked="" type="checkbox"/> Specification [Total Pages 10] (preferred arrangement set forth below) - Descriptive title of the Invention - Cross References to Related Applications - Statement Regarding Fed sponsored R&D - Reference to Microfiche Appendix - Background of the Invention - Brief Summary of the Invention - Brief Description of the Drawings (if filed) - Detailed Description - Claim(s) - Abstract of the Disclosure | 7. Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary) a. <input type="checkbox"/> Computer Readable Copy b. <input type="checkbox"/> Paper Copy (identical to computer copy) c. <input type="checkbox"/> Statement verifying identical of above copies |
| 3. <input checked="" type="checkbox"/> Drawing(s) (35 USC d113) [Total Sheets 7] | |
| 4. Oath or Declaration [Total Pages 1] a. <input checked="" type="checkbox"/> Newly Executed (original or copy) b. <input type="checkbox"/> Copy from a prior application (37 CFR §1.63(d)) (for continuation/divisional with Box 17 completed) [Note Box 5 below] i. <input type="checkbox"/> DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR §1.63(d)(2) and 1.33(b). | |
| 5. <input type="checkbox"/> Incorporation By Reference (useable if Box 4b is checked) The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein. | |

ACCOMPANYING APPLICATION PARTS

- | | |
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| 8. <input checked="" type="checkbox"/> Assignment Papers (cover sheet & Documents(s)) | |
| 9. <input type="checkbox"/> 37 CFR §3.73(b) Statement (when there is an assignee) | <input type="checkbox"/> Power of Attorney |
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*A new statement is required to be entitled to pay small entity fees, except where one has been filed in a prior application and is being relied upon

17. If a **CONTINUING APPLICATION**, check appropriate box and supply the requisite information below and in a preliminary amendment:

☐ Continuation

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of prior application No: /

Prior application information: Examiner

Group / Art Unit:

18. CORRESPONDENCE ADDRESS



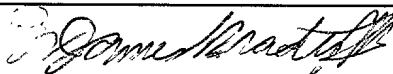
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APPLICATION INFORMATION

STRAPLESS LEAD FRAME

FIELD OF THE INVENTION

This invention relates to semiconductor devices, and more particularly to a lead frame, used with a heat slug, without tie straps providing for evenly distributive bond wires at the corners of the semiconductor die.

BACKGROUND OF THE INVENTION

High pin count lead frames have closely spaced inner leads. Lead frames which have tie bars connecting the lead frame to the die pad tend to cause crowding of the lead frame leads and bond wires at the corners of the semiconductor die.

lead from one side of the lead frame, located where the tie strap is normally located, is connected via a bond wire to a bond pad on the semiconductor die on a side adjacent to the side where the lead frame lead is located.

The technical advance represented by the invention, as well as the objects thereof, will become apparent from the following description of a preferred embodiment of the invention when considered in conjunction with the accompanying drawings, and the novel features set forth in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a prior art lead frame having tie straps connecting the corners of the die mount pad;

FIG. 1a shows a prior art lead frame with a rectangular die pad;

FIG. 2 is a partial view of the lead frame of FIG. 1;

FIG. 3 is a partial view of the lead frame of FIG. 1, the same as FIG. 2, with the tie strap removed;

FIG. 3a is an enlarged view of a portion of FIG. 3 showing the crowding of the bond wires;

FIG. 4 shows the redistribution of lead frame leads and bond wires in the area where the tie bar has been removed; and

FIG. 4a is an enlarged view of a portion of FIG. 4 showing the improvement of bond wire distribution according to the invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

FIG. 1 is a prior art lead frame having a plurality of leads 11, a die mount pad 12 and four tie straps 13-16, which are attached to the die mount pad. Lead tips 11a are evenly spaced, but the combination of the corner of the semiconductor device and the bond pads thereon present lead routing problems as described below in FIGS. 3 and 3a.

The lead frame of FIG. 1a presents a greater problem in that the semiconductor die to be mounted in the lead frame is rectangular with a greater number of leads on, for example, side a than on smaller size side b.

FIG. 2 is an enlarged partial view of the lead frame of FIG. 1, showing one tie strap 14 and leads 11. The leads 11 adjacent to tie strap 14 have to be bent around tie strap 14. This requires all the leads to be positioned in a smaller space because of the space required by tie strap 14.

FIG. 3 is the same view of lead frame of FIG. 2 with tie strap 14 removed. Semiconductor die 18 is shown with bond pads 19. Bond

pads 19 are attached to lead frame leads 11 with bond wires 17. The bond wires 17 attached to bond pads 19 at positions removed from the semiconductor die corner 18a are fairly evenly spaced. However, the bond wires 17a and 17b are not adequately spaced, with a possible resulting short between the bond wires. This is especially true for the rectangular semiconductor die where bond wires from lead frame leads on one side of the lead frame are connected to bond pads on the adjacent side of the semiconductor die.

FIG. 3a is an enlarged partial view of FIG. 3 showing a portion of the leads 11, bond pads 19 on semiconductor die 18, and bond wires 17. The spacing in this enlarged view FIG. 3a shows the poor spacing between leads 17a and 17b as a result of the tie strap spacing.

FIG. 4 shows a partial view of a lead frame with the tie strap removed, and the leads 20 positioned so that the ends 20a of leads 20 are evenly spaced around the corner of semiconductor die 21. Lead ends 20a are connected to bond pads 22 on semiconductor die 21. The spacing of bond wires 23 is evenly spaced as is the spacing between lead frame lead 20 and bond pads 22.

An advantage of the lead frame without a tie strap is that there is a tooling saving in that there is no need for tooling to cut the tie strap, and the resulting lead frame has a wider lead pitch at the corner of the semiconductor die and lead frame for high pin count packages.

FIG. 4a is an enlarged view of a portion of FIG. 4 clearly showing the improved spacing of the bond wires 23a and 23b. When compared with the spacing of bond wires 17a and 17b of FIG. 3 and FIG. 3a, the improvement of the lead frame leads spacing and the bond wire spacing of the lead frame without the tie strap is clearly seen. Bond wires 23a and 23b are from lead frame leads from one side of the lead frame that extend to bond pads on the adjacent side, or from lead frame leads that are in the space where the tie strap has been removed. As illustrated, leads 23a and 23b would be attached to bond pads on side of semiconductor die 21 if die 21 were square. However, since die 21 is rectangular, leads 23a and 23b extend to side d of die 21. If there were tie bars on the lead frame, this would not be possible since leads 23a and 23b would cross over the tie bar.

Since there are no tie bars to hold a die mount pad in place, in this embodiment, the semiconductor die is supported by a heat

slug 30 which is taped under the lead frame. Heat slug 30 is taped to lead 20s and serves as both a heat sink and a die mount pad.

WHAT IS CLAIMED

1. A strapless lead frame/heat slug combination, comprising:
a plurality of lead frame leads distributed around a semiconductor die mount area, and extending into the area normally occupied by the lead frame strap; and
a heat slug attached under the lead frame with tape providing the die mount area.
2. The strapless lead frame according to Claim 1, wherein the semiconductor die has four sides and the lead frame leads are evenly distributed on each of the four sides.
3. The strapless lead frame according to Claim 1, wherein the lead frame has four sides and two of said four sides have a different number of leads from two other sides.
4. The strapless lead frame according to Claim 1, where in said semiconductor die has a different number of bond pads on adjacent sides, and at least one of said bond pads is attached to a bond wire attached to a lead frame lead on a side of the lead frame adjacent to the side of the semiconductor die on with the bond pad is located.

5. A strapless lead frame for use with heat slug packages, comprising:

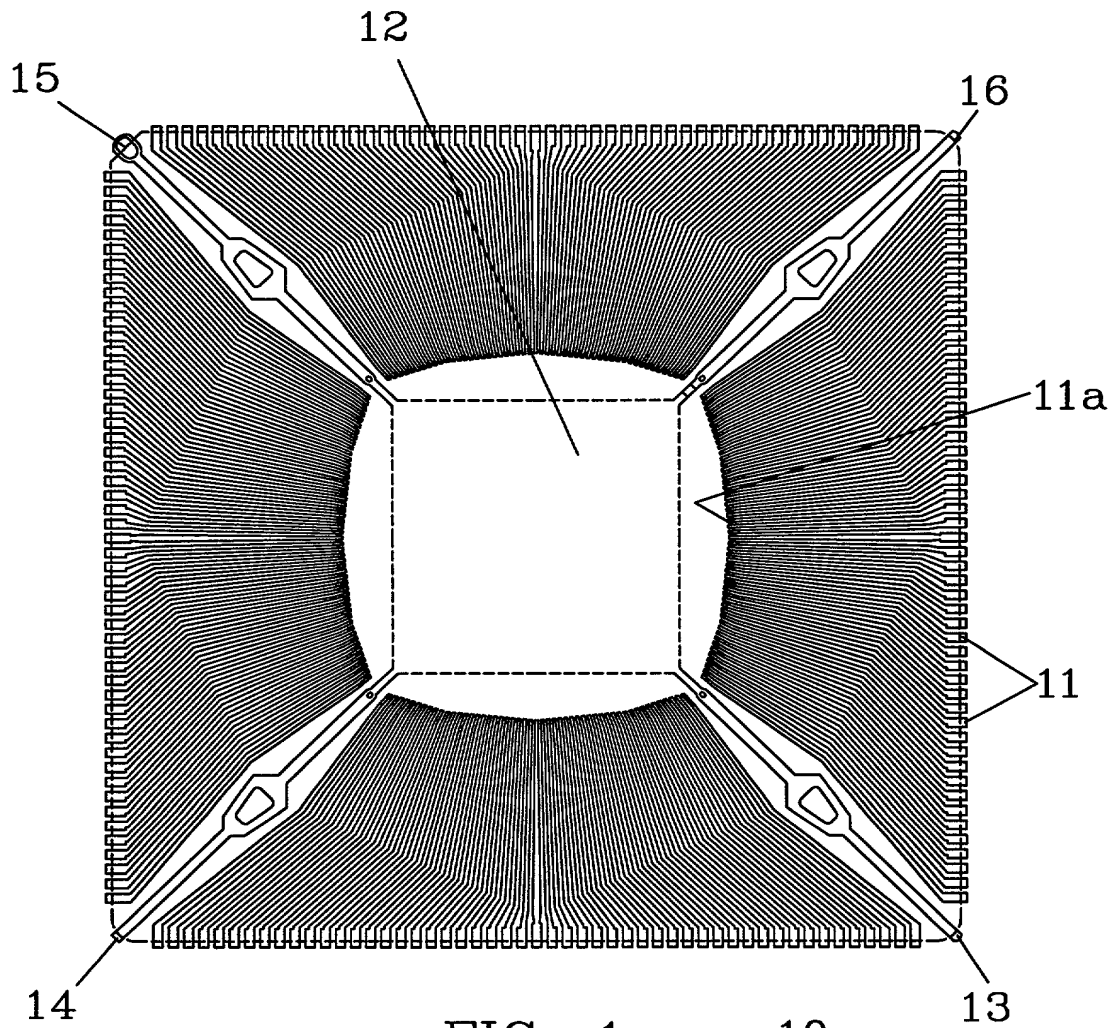
a plurality of lead frame leads distributed around a semiconductor die mount area, and extending into the area normally occupied by the lead frame strap;

a heat slug attached under the lead frame with tape providing a rectangular die mount area, there being the same number of lead frame leads on opposites sides of the lead frame and a different number of lead frame leads on adjacent sides of the lead frame.

6. The strapless lead frame according to Claim 5, including a semiconductor die with a different number of bond pads on adjacent sides and the same number of bond pads on opposite sides, and at least one of said bond pads is attached to a bond wire attached to a lead frame lead on a side of the lead frame adjacent to the side of the semiconductor die on which the bond pad is located.

ABSTRACT OF THE DISCLOSURE

A lead frame that does not have tie straps and a die bond pad is rectangular in shape, with the same number of lead frame leads(11) on opposite sides and a different number of lead frame lead frame leads (11) on adjacent sides. Lead frame leads (11)extend into the area in which the tie strap would normally be placed. A heat slug is (30) taped to the lead frame to provide a semiconductor die mount area. At least one lead (11) from one side of the lead frame, located where the tie strap is normally located, is connected via a bond wire (17a,17b) to a bond pad (19) on the semiconductor die (18)on a side adjacent to the side where the lead frame lead is located.



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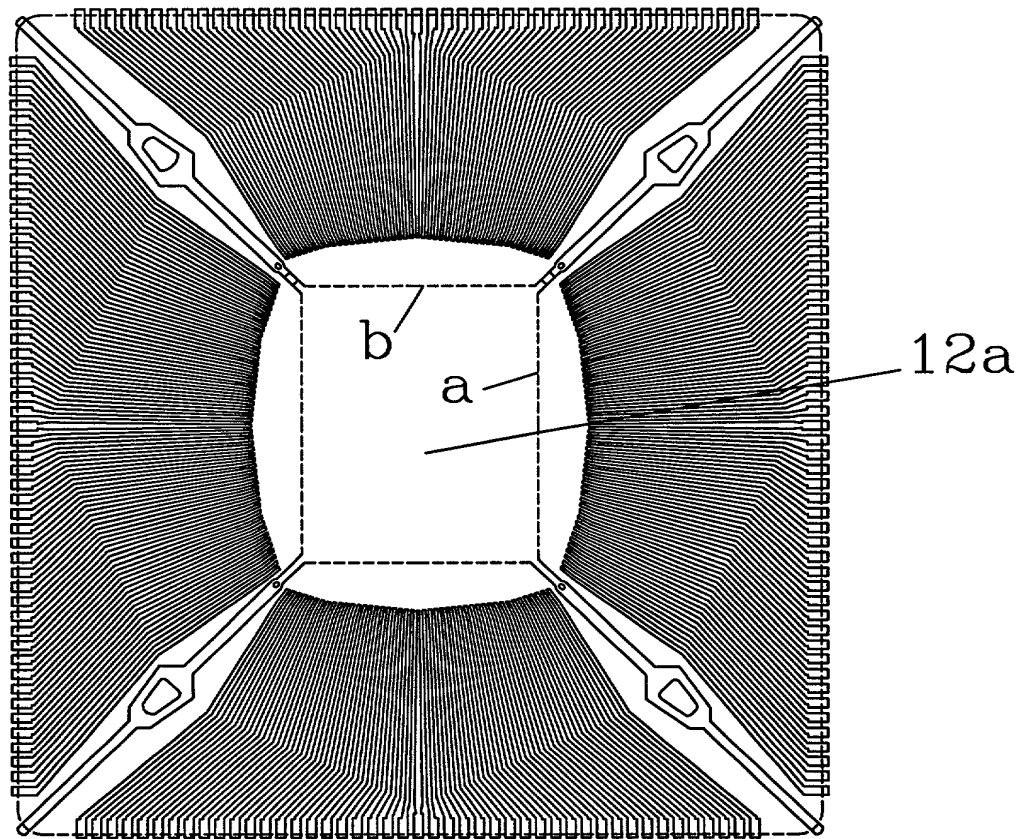


FIG. 1a

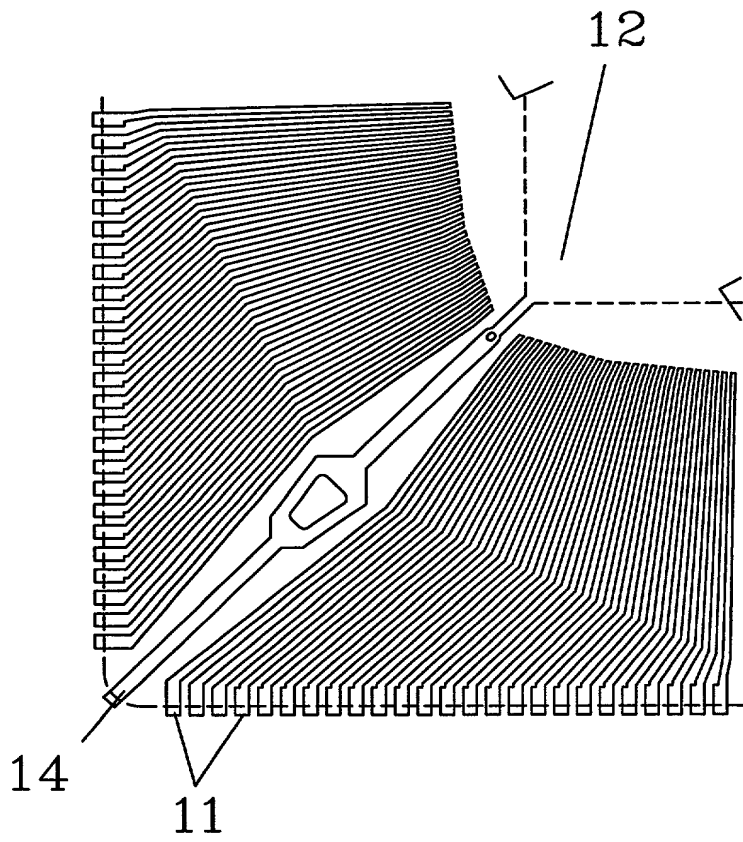


FIG. 2
(Prior Art)

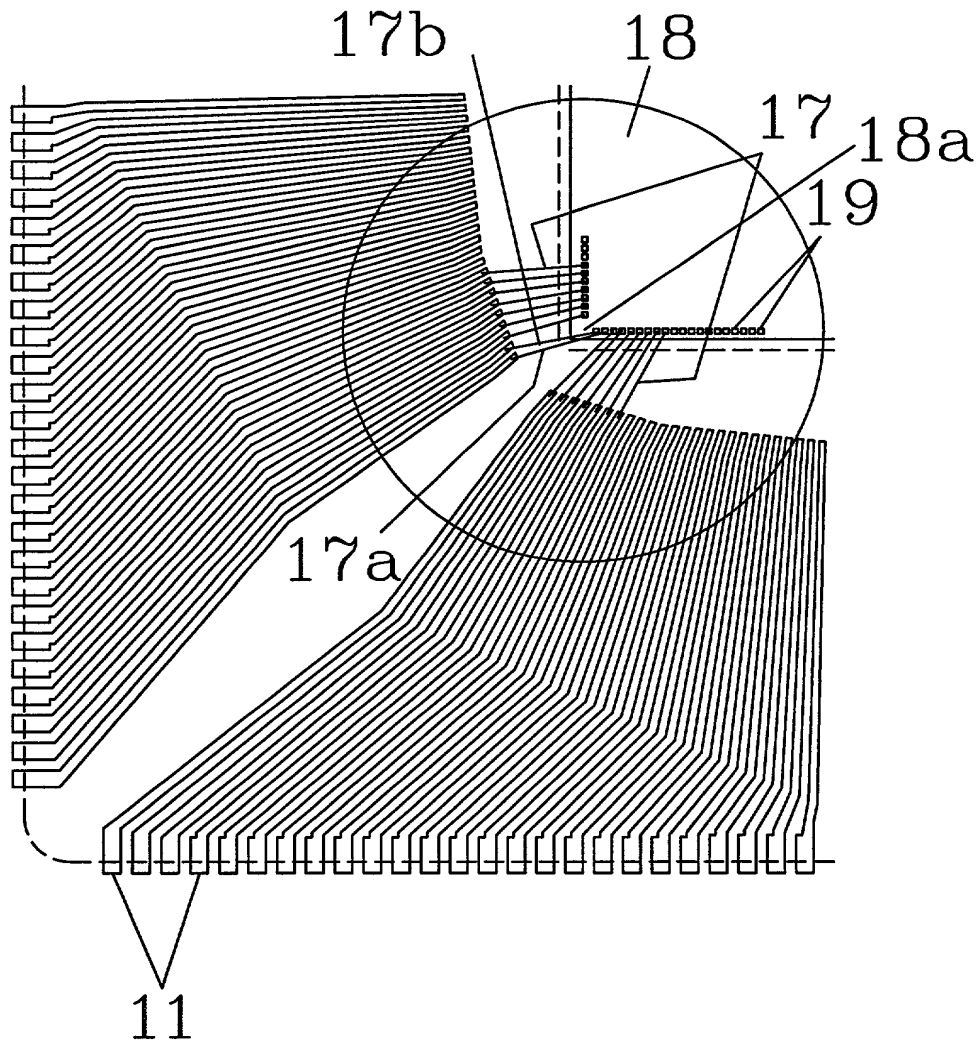
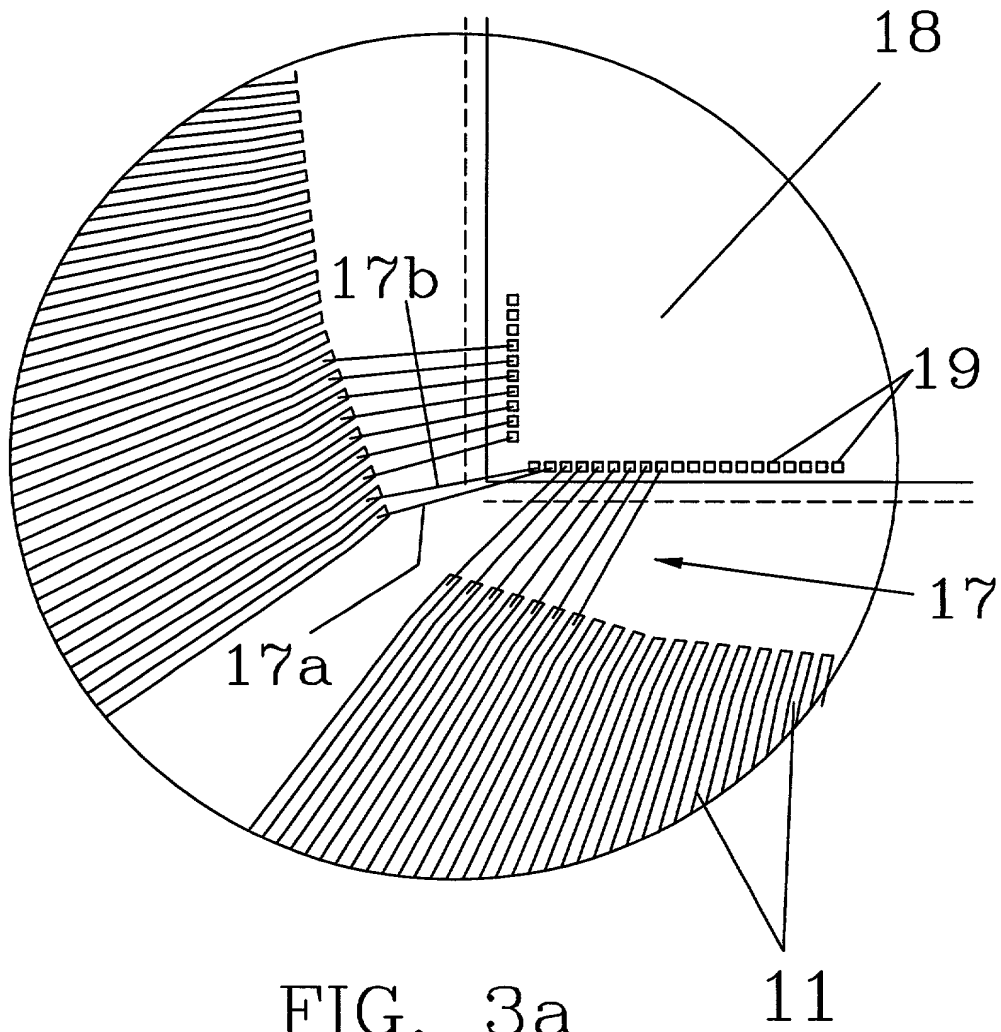


FIG. 3
(Prior Art)



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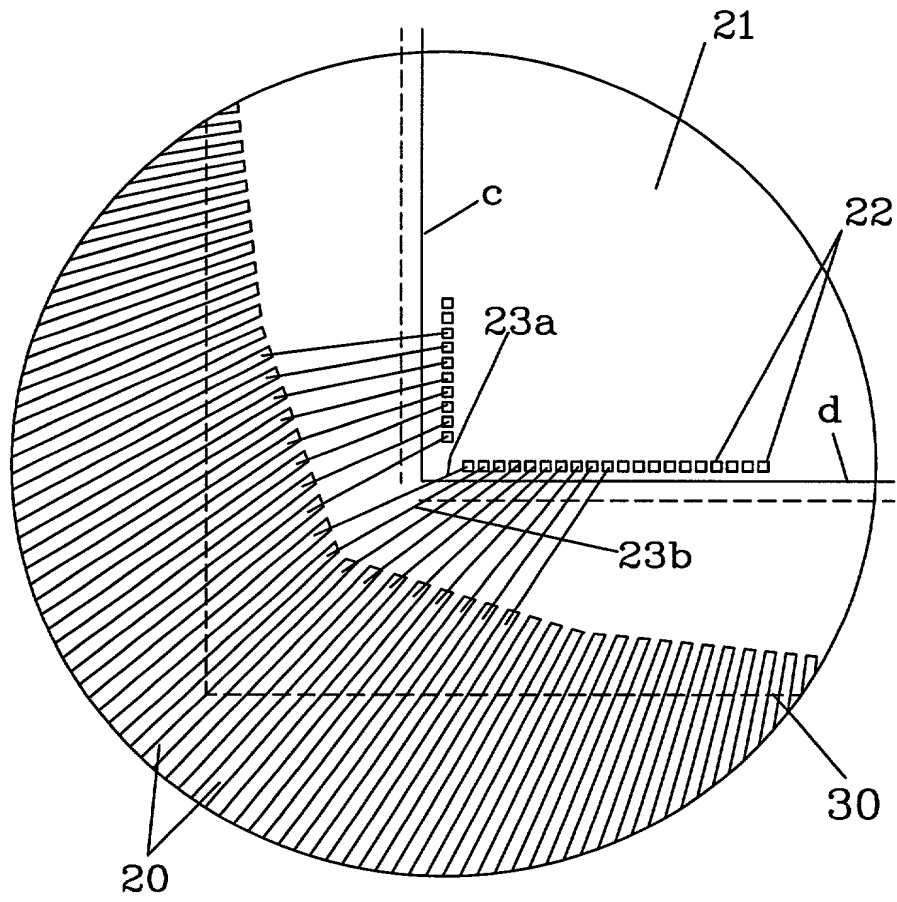


FIG. 4a

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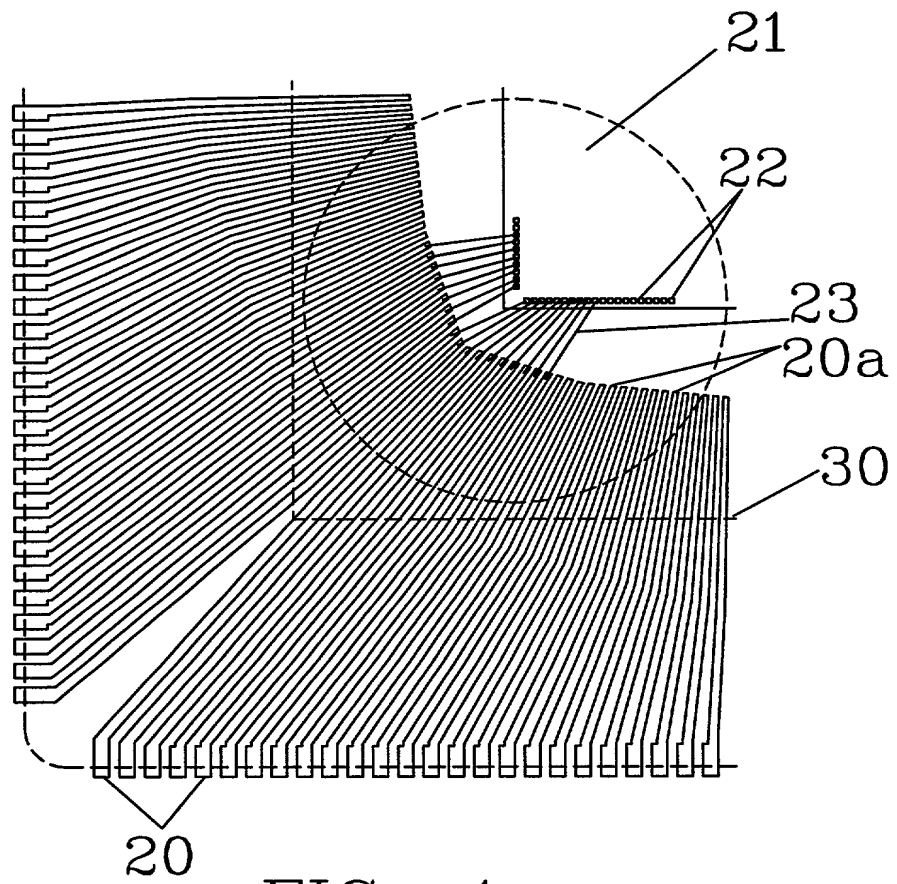
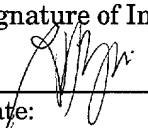
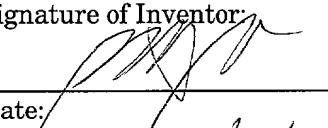


FIG. 4

APPLICATION FOR UNITED STATES PATENT
DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I declare that my residence, post office address and citizenship are as stated below next to my name; that I verily believe that I am the original, first and sole inventor if only one name is listed below, or an original, first and joint inventor if plural inventors are named below, of the subject matter which is claimed and for which a patent is sought on the invention entitled as set forth below, which is described in the attached specification; that I have reviewed and understand the contents of the specification, including the claims, as amended by any amendment specifically referred to in the oath or declaration; that no application for patent or inventor's certificate on this invention has been filed by me or my legal representatives or assigns in any country foreign to the United States of America; and that I acknowledge my duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, section 1.56;

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

| | | |
|--|---|---|
| TITLE OF INVENTION: STRAPLESS LEAD FRAME | | |
| POWER OF ATTORNEY: I HEREBY APPOINT THE FOLLOWING ATTORNEYS TO PROSECUTE THIS APPLICATION AND TRANSACT ALL BUSINESS IN THE PATENT AND TRADEMARK OFFICE CONNECTED THEREWITH. W. James Brady III, Reg. No. 32,080 Richard L. Donaldson, Reg. No. 25,673 William B. Kempler, Reg. No. 28,228 Jay M. Cantor, Reg. No. 19,906 | | |
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